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AUTHOR Anderson, Calvin E.; Bottinelli, Charles A.
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ABSTRACT

The Schoolhouse Energy Efficiency Demonstration (SEED) program was developed to assist schools in reducing the impact of rising energy costs. Developed as part of the SEED program, this publication was designed to provide background information on the energy issue and to briefly describe what future energy sources may be. It includes: (1) background information on the energy issue, discussing energy conservation, oil and natural gas, coal, nuclear energy, synthetic fuels, and renewable energy resources; (2) examples of what schools are doing about energy, including the role of teachers in energy conservation; (3) suggested ways in which a school building can be used to teach energy, emphasizing energy conservation; (4) a "Student Schoolhouse Energy Survey," for student/teacher use; (5) examples of how energy education can be used outside in the classroom and in extracurricular and community projects; and (6) an exercise that will help teachers "energize" existing curricula. This exercise consists of listing traditional concepts considered essential in the teaching of a subject area and, for each concept, identifying and writing down the hidden energy concept and developing an activity (or modifying an existing one) which emphasizes the hidden energy concept. Sample lesson plans from other energy education programs are included. (Author/JN)

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SOMETHING SPECIAL FOR TEACHERS

A Schoolhouse Energy Teaching Program

SEED

LEARNING ABOUT ENERGY EFFICIENCY THROUGH REASON

***A Public Service Program
Sponsored by***

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Houston, Texas 77001

The following organizations encourage and recommend the Schoolhouse Energy Efficiency Demonstration (SEED), sponsored and developed by Tenneco Inc., Houston, Texas:

American Association of School Administrators
American Vocational Association
Association of School Business Officials
Council for American Private Education
Council of Chief State School Officers
Education Commission of the States
National Association of Elementary School Principals
National Association of Secondary School Principals
National Association of State Boards of Education
National Congress of Parents and Teachers (PTA)
National Education Association
National School Boards Association

The curriculum components for SOMETHING SPECIAL FOR TEACHERS were prepared by:

Calvin E. Anderson, Ph.D.
Director of Energy Conservation
Jefferson County Public Schools
809 Quail Street
Lakewood, Colorado 80215
Charles A. Bottinelli, Ph.D.
Energy Information Associates, Inc.
2690 West Main Street
Littleton, Colorado 80120

Technical review and comment were provided by Tenneco's education consultant:

Dr. Edward P. Keller
Deputy Executive Director
National Association of Elementary School Principals
1801 North Moore Street
Arlington, Virginia 22209

Materials in this publication were tested by teachers (grades K-12) who attended the Community Resources Workshop in Racine, Wisconsin, July 1980.



FOREWORD

This publication is a part of the SEED program, Schoolhouse Energy Efficiency Demonstration.

SEED, a public service program developed by Tenneco Inc., is designed to assist schools in reducing the impact of rising energy costs by developing effective energy management programs and recommending low-cost, quick-fix solutions to energy inefficiencies.

The original SEED program had both a technical and a public awareness component. The technical component consisted of twenty demonstration school energy audits conducted during the 1978-1979 school year by architectural and engineering consultants to Tenneco Inc. During each audit, the consultants surveyed the building, identifying areas of energy inefficiency and developing solutions.

The results of the twenty-school study indicated that the typical school could reduce its energy consumption an average of 48.6 percent. Most of the savings can be achieved through low-cost maintenance and operating improvements. No new exotic technology is required and most of the costs can be paid from the normal operating budget.

The public awareness component was developed to assist the school administrator in gathering public support for energy management programs. The general theme was that rising energy costs, if not offset by efficiencies, may adversely affect educational programs.

THE FOURTH R, a 21-minute film, was produced to increase public awareness. A booklet, THE FOURTH R: RESOURCEFULNESS IN SCHOOL ENERGY CONSERVATION, describing school energy problems and appropriate solutions, accompanies the film. In addition, a report on the first year of SEED was published. Called SOMETHING SPECIAL FROM SEED, this report includes a summary of the twenty-school study, a "Classroom Guide" designed for teachers and students, and a "Technical Manual" designed for use by the non-technical person in conducting an energy audit.

These publications and the film are available to the education community free of charge by writing:

Public Affairs Department
Tenneco Inc.
P.O. Box 2511
Houston, Texas 77001

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SOMETHING SPECIAL FOR TEACHERS

A SCHOOLHOUSE ENERGY TEACHING PROGRAM

Energy will be recorded one of the most discussed topics of the last quarter of the Twentieth Century. The energy issue affects every aspect of our lives, including the fundamentals of food, shelter and clothing.

The production of sufficient food for a growing world population depends on energy. Our houses, both their construction and operation, depend on energy. And, the manufacture and shipment of goods from one place to another depend on energy.

Where will the energy come from? How will we get it? What form will it take? Will there be enough? These are just some of the questions asked.

Virtually every segment of the American society has taken part in the discussion of the energy issue. And, virtually every segment of society has been asked to take part in its solution. Now, the education community, teachers in particular, is being asked to transmit to its students the essential information that will ensure that future generations of Americans will be energy conscious.

Essential to the successful completion of this task is an understanding of the overall energy picture and how the nation arrived at this point. Further, it is important to understand how our individual and collective actions can significantly affect the energy picture.

This publication, **SOMETHING SPECIAL FOR TEACHERS: A Schoolhouse Energy Teaching Program**, is designed to provide background on the energy issue and to describe briefly what our future energy sources may be. It includes:

- A chapter titled "The School as an Energy Conservation Laboratory," containing suggested ways in which the school building can be used to teach energy, emphasizing energy conservation;
- A "Student Schoolhouse Energy Survey," which teachers and students can use to examine their own school and determine its energy efficiency;
- Examples of how energy education can be used outside the classroom in extracurricular and community projects; and
- An exercise that will help teachers "energize" existing curricula.

In summary, **SOMETHING SPECIAL FOR TEACHERS: A Schoolhouse Energy Teaching Program** is designed to assist teachers in using the school facility and existing curricula to teach energy, its consumption and its conservation.



THE ENERGY ISSUE

Energy is one of the most important issues facing mankind. The world has entered an energy transition that may take decades to complete. We are moving from an era of cheap and plentiful oil and natural gas, our primary energy resources, to an era characterized by a combination of expensive and limited conventional fuels, synthetic fuels, and renewable energy resources.

During the 1970's a great deal of debate centered on the energy issue. Much of the rhetoric was "the world is running out of energy". It was a confusing time. Some people felt the problem was overstated; others felt it was understated. There was little agreement on how serious the energy problem was or would become.

With the advent of supply shortages and rising prices, the late 1970's confirmed the reality and seriousness of the energy problem. Gasoline, heating oil, natural gas and electricity prices rose, reflecting supply problems. For a time, lines of cars formed at the gasoline pumps and part of the nation was placed on an odd-even system of rationing.

It was during this decade that America became dependent on importing much of its oil — nearly half in 1979. The continuation of this trend through the 1980's would not be a wise course of action because it is based upon the good will and political stability of the exporting countries. In addition, the cost of importing this much foreign oil was nearly \$90 billion in 1980, seriously weakening the U.S. economy.

Many Americans were surprised to learn the extent of our dependence on foreign oil. This realization, combined with the fact that our traditional energy resources are finite and that energy will no longer be cheap and easy to obtain, has brought us to a point of agreement that we must take action to solve this problem.

In response to our determination to face up to the energy problem, in 1978, Congress passed the National Energy Act which sets out the nation's energy goals and serves as a guide to energy activities. The overall goal of the National Energy Act has two thrusts:

- to encourage the most efficient use of existing energy supplies; and,
- to assure an adequate supply of energy for the future.

With this stated goal, the confusion surrounding the energy issue is beginning to fade. America is coming to grips with the energy problem. Most experts, including academicians, government representatives, business consultants and energy industry planners, now agree that the energy problem is real and serious. They expect that the threat of higher prices and supply shortages will exist for some time. And, all agree that the energy issue will be with us for the remainder of this century, influencing social, political, economic and international affairs.

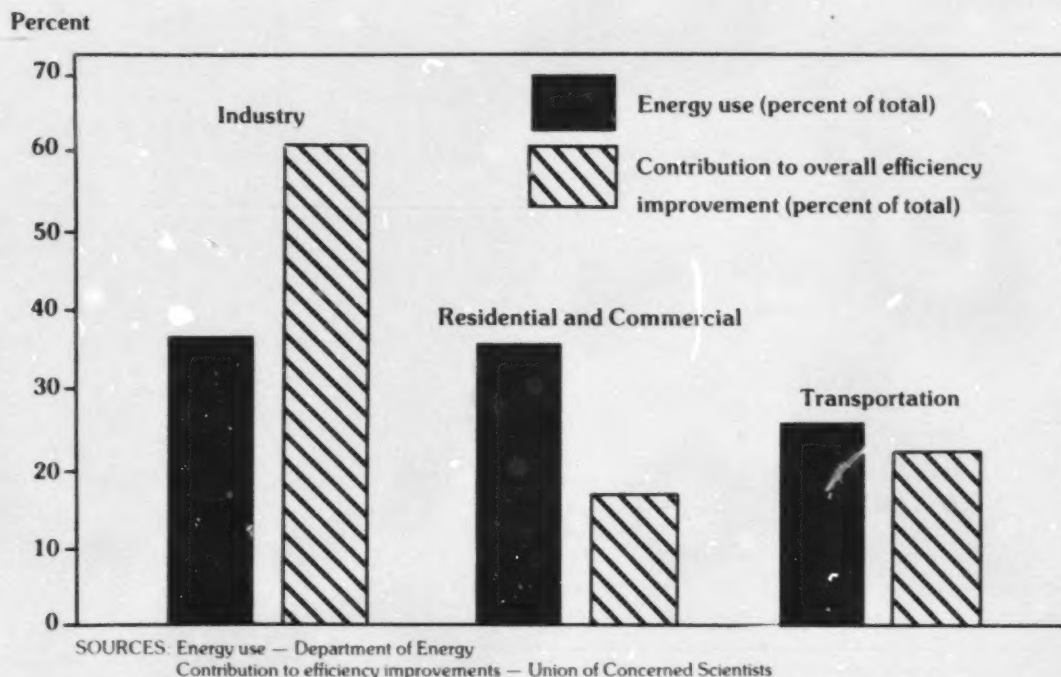
As they have done so often in the past, Americans are rising to meet the energy challenge. The message of the 1980's can become one of confidence in our ability as a nation to meet the challenge, solve the problem and ensure America's energy security.

Energy Conservation

All Americans, if they choose to do so, can play a key role in ensuring this nation's energy future by practicing energy conservation. A Harvard Business School study concluded that "energy conservation is itself a form of productive investment." Further, it states that conservation is the cheapest, cleanest and fastest means of decreasing our dependence on foreign oil.

Americans are already using energy more carefully. From 1973 to 1980, as the cost of energy went up, the rate of growth in consumption declined dramatically. In fact, projections for total U.S. energy consumption in 1990 have dropped by 20 percent because of higher prices and conservation efforts.

This chart compares the overall percentage of energy use to percentage of contribution to energy improvements by sectors of society: industry, residential and commercial, and transportation. Schools, hospitals and office buildings fall into the commercial category. This chart illustrates that a lot of progress is being made. A recent study by the Union of Concerned Scientists shows that improvements in energy efficiency in the U.S. saved the equivalent of 1.3 billion barrels of oil between 1973 and 1978.



However, Americans can achieve even more through conservation. Two important targets for energy conservation are homes and cars. In our homes, we are adding insulation, caulking and weatherstripping. We are adjusting thermostats to use less cooling and heating. And, we are installing home appliances that are more energy efficient.

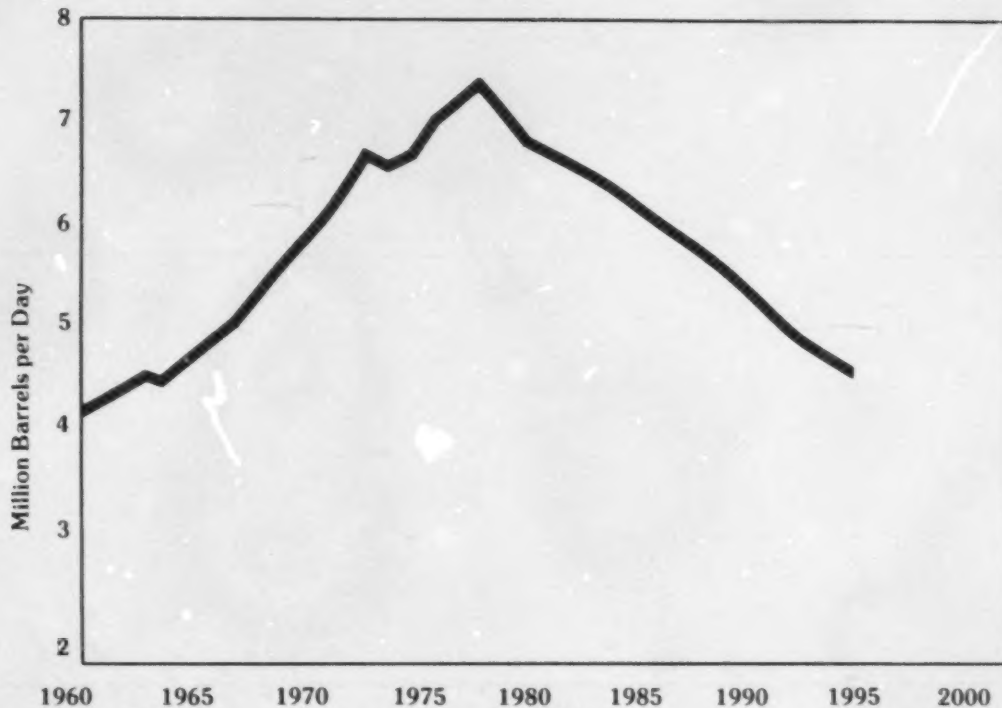
Gasoline conservation has met with remarkable results. We are purchasing fuel efficient automobiles and driving them slower. More than ever, people are car pooling, van pooling and using public transportation.

Schools, hospitals and other public institutions have become more energy conscious. According to the American Association of School Administrators, American schools "slashed their school building energy use per square foot by 37 percent from 1973 through 1979."

Business and industry have become more energy efficient too. Since 1972, while production has increased nearly 27 percent, industrial energy use has increased only 7 percent. Most of this reduction has been achieved through better training, better "housekeeping" procedures and capital investment in efficient equipment.

Much of the movement toward conservation has been spurred by higher prices. Nonetheless, energy conservation and those who practice it can contribute significantly to meeting America's energy goals. As we move through the 1980's, we can expect even greater progress in energy conservation because of public education and new product development.

GASOLINE CONSUMPTION



SOURCES: Historical — U.S. Department of Energy
Projections — Arthur D. Little, Inc.

Increased energy efficiency and conservation address the first point of the National Energy Act. However, even with greater conservation, most experts believe that the demand for energy will increase because of our growing population and natural desire for an increased standard of living. Therefore, we must make every effort to assure that future energy supply will meet this increasing demand.

It is difficult to predict with any precision the sources and amounts of energy supplies required over the coming decades. For the 1980's oil and natural gas will continue to play a leading role. For the long term, new and promising technologies are emerging for deeper drilling, enhanced oil recovery, cleaner burning of coal, the development and use of nuclear and solar power, and other forms of renewable energy.



Oil and Natural Gas

Responding to the need to find more energy, domestic producers have increased exploration activities. They are reexamining areas that were productive in the past. They are exploring in new areas, such as the Outer Continental Shelf, Alaska, and the Rocky Mountain Overthrust Belt. Increased exploration activities in 1979 resulted in new increases in proved oil reserves in 10 states. Gas reserves increased in 17 states.

Using new technology, U.S. producers are drilling deeper than ever before. They have developed new methods to increase oil recovery, involving the use of heat, chemicals and various gases to cause oil in rock formations to flow to the pump.

In 1979, this country's producers drilled more wells than in any 12-month period of the past 20 years. All of this increased activity is beginning to pay off. Instead of finding only half as much oil as was drawn from proved reserves, the nation's producers added to reserves about three-fourths as much as was used up. In 1980, drilling was up again to the highest level in history. Studies also indicate that remaining natural gas reserves plus future discoveries could total 40 percent more than has been produced to date. Industry forecasters now believe that the decline in U.S. production during the 1970's can be halted during the 1980's.

Coal



Recognizing the serious situation created by depending primarily on conventional sources of oil and natural gas for energy, Americans began looking for other energy sources — old as well as new. Coal was rediscovered.

Coal is the most abundant fossil fuel in the United States, comprising more than three-fourths of the known recoverable energy reserves. Further, the United States has more than half of the free world's coal resources. America can realize two benefits from its abundance of coal. By effectively utilizing the nation's coal resources, America can begin to ensure its energy security, and by using coal as an export commodity, it can take a step toward achieving a positive balance of payments.

Coal was first mined commercially in 1790 in Virginia. By the mid-1850's, coal had become the country's principal fuel, powering America from an agrarian to an industrialized society. However, the use of coal began declining in the 20th Century. Until recently, coal provided less than 20 percent of the nation's energy requirements. Despite America's enormous growth in the 1950's and 1960's, the overall demand for coal increased by less than 3 percent per year. However, because of the complexities of the oil supply situation and a shift in government policy, coal production from 1979 to 1980 increased by 10 percent.

One of the chief arguments against the increased use of coal is that it cannot be mined or burned without serious environmental damage. Critics of increased use of coal point to abandoned, ugly mines which dot the landscape, and air and water pollution caused by sulfur and ash emissions. Fortunately, the technology already exists, and is in use, to mine and burn coal in environmentally acceptable ways. Further, there are both state and Federal laws that require the restoration of mined lands and the protection of air and water resources. Environmental controls are costly. However, because of the high price of foreign oil, the cost of using coal is still less than half the cost of using oil.

In addition to the conventional burning of coal for generating electrical energy, it can be changed to liquid and gaseous fuels, directly replacing petroleum. Thus, the nation can expand the use of coal through direct burning, liquefaction and gasification, thereby contributing to its energy security, while continuing to maintain the quality of the environment.



Nuclear Energy

No discussion of the energy future of America would be complete without discussing the safe development and use of nuclear power. President Carter stated in a report on the accident at Three Mile Island:

"We cannot shut the door on nuclear energy. Every source of energy, including nuclear power, is critical, if we are to free our country from its over dependence on unstable sources of high-priced foreign oil."

There are currently 72 reactors with operating licenses. Another 89 reactors have construction permits and two have limited work authorizations. In addition, 19 are on order.

During 1979, nuclear plants provided about 12 percent of the electricity produced in the United States, including one-third of the electricity for Boston. The use of nuclear power can increase over the next decade with careful

attention to the problems of availability of uranium enrichment and processing services, spent fuel storage, licensing and safety. Technologies currently exist which can help to overcome these problems.

The investigations and studies conducted following Three Mile Island indicate that the human element is critical in the operation of nuclear power plants. Government and industry are focusing on improvements in operational training and procedures in an effort to ensure that nuclear power can play its part in America's energy future.



Synthetic Fuels

Continuing our search for solutions to the energy problem, we find that a new generation of energy resources is emerging. These new sources, called synthetic fuels, include oil and gas made from coal, and oil extracted from shale and tar sands. Some technologies for these energy sources are already available. For example, the technology for extracting oil from shale is more than a hundred years old. The conversion of coal into oil or synthetic gas began in the early part of this century.

- Coal to Gas and Oil

Gasification of coal is accomplished by reacting coal with oxygen and steam. This produces a mixture of gases containing carbon monoxide and hydrogen. These gases are cleaned to remove solids and other impurities. Clean gas is catalytically converted to methane, the major ingredient of natural gas. Clean gas can be used to produce various chemicals or to supply energy. Several gasification processes are used commercially overseas and are now being tried on coals in this country. Considerable effort is being made to develop more efficient and more economical processes for use with U.S. coals.

Several methods for converting coal into liquid fuels exist. They are classified as direct or indirect liquefaction processes. Direct liquefaction involves conversion of coal into liquids and gases either by controlled heating of coal as in pyrolysis, by solvent extraction as in solvent refined coal processes or by catalytic hydrogenation of coal. Indirect liquefaction entails conversion of coal to gases as described above and catalytic conversion of clean gases to liquid products.

Coal conversion efficiencies range from sixty to eighty percent depending upon the products desired. Compared with thirty-five to forty percent efficiency for power generation, coal conversion to gas or liquid represents much improved utilization of coal resources.

- Oil From Shale

The production of oil from shale rock was used as early as the 1850's. Shale is a marlstone that contains a solid substance called kerogen, which is partially formed oil. Shale can be mined underground (in situ) or on the surface. In the underground process some of the rock is mined and the rest is fractured and heated beneath the surface. The heat releases the oil into wells leading to the surface.

Facilities to extract oil from shale and convert coal to gas are currently under construction. It is expected that products from these facilities will reach the market place in the mid 1980's.

- Oil From Tar Sands

Tar sands are sands saturated with heavy oil and tar. Where the sands are shallow, they can be surface mined and the oil recovered with heat. Where the deposits are deep, in situ methods must be used. One such method is to drill conventional oil wells and inject steam to melt the tar. Another method is to create an underground fire. In both cases, the liquid is then pumped to the surface through heated pipes.

- Biomass Conversion

Another means of producing synthetic fuel is through the conversion of plant matter, biomass, to liquid fuel or gas. Biomass includes every kind of organic substance that can be turned into fuel. Wood and dry plant or organic waste can be burned directly to generate heat and electricity. All matter that contains starch or sugar can be converted to alcohol. And, bacteria can break down organic waste from garbage and sewage to form methane. The potential of biomass is considerable. Government and industry experts estimate that biomass fuels will make a meaningful contribution to the nation's energy supply.

Large scale "synfuel" production will require more than the revival of old technologies. Government and industry are investing enormous sums of money in our energy future by jointly funding research projects to develop methods for converting coal, shale and tar sands into synthetic fuels. Production facilities are already under construction and should contribute significantly to America's energy supply by 1990.



Renewable Energy Resources

Biomass conversion is both a synthetic and a renewable energy source. Several other forms of energy are classified strictly as renewable, including solar, geothermal and hydropower.

Renewable resources are those that derive energy from natural forces such as the earth's heat (geothermal energy), the ocean's tides, rivers, winds and the sun. Geothermal energy, tidal and water power, and wind power can generate electricity indirectly by turning turbines or fans. Windmills have long been used to pump water and generate electricity.

Two processes use solar power: solar thermal, the use of the sun's heat for heating and cooling; and photovoltaics, the conversion of the sunlight directly into electricity by means of solar cells. Government, academia and industry have joined forces in the area of renewable energy resources in an effort to develop these potential fuel sources to their fullest.

Solar thermal systems are the most developed and simplest of the solar technologies. Passive solar systems are architectural designs that take advantage of the site and building materials to turn the building into a solar collector.

Active solar thermal systems involve pumps and fans to move a fluid through the system. The basic unit is the solar collector, or a panel made of aluminum, glass, plastic or copper. These panels absorb sunlight and transfer heat to a fluid that passes through the collector. The fluid flows through pipes into the building, where it can be used to heat water, warm rooms or provide heat for industrial processes.

Hydropower and geothermal energy are two important renewable resources that already contribute to the nation's energy supply. Hydropower is electricity generated by water as it falls and turns turbines. The supply of conventional hydropower is limited because there are few sites for new dams.

Geothermal energy is produced from heat deep within the earth. Beneath the earth's surface is molten rock which in some places has pushed up close to the earth's crust. When underground water flows over these hot rockbeds, the water or steam rises through cracks in the earth. Geysers such as Old Faithful in Yellowstone National Park, fumaroles and hot springs are visible signs of geothermal activity and potential sources of energy.

Geothermal resources in the United States are tremendous. While only one geothermal source currently supplies commercial electric power, government and industry are experimenting with other forms of geothermal energy. Before these experimental projects become commercially viable, numerous economic and technical problems must be solved. For example, drilling costs in geothermal zones are twice as high as in onshore oil and gas wells at similar depths. Equipment also needs to be developed that can resist the high temperatures deep within the earth.

In addition to geothermal and hydroelectric power, other natural resources such as wind and tidal forces could become important contributors to our energy mix. Scientists currently are conducting research on ocean tides, and the aerospace industry is investigating new methods of generating electricity from wind.

The development of all of these renewable resources taken together with synfuels, coal, oil, natural gas and conservation can lead America into an era of energy security. The energy future of America can be a safe, clean, secure one, if we choose to make it so.



THE SCHOOL ENERGY PROBLEM

The problems associated with energy supply and accompanying escalating costs pose a unique situation for schools. Two problems emerge: one is the rising cost of energy and the other is its efficient use.

The typical school budget allocates 85 percent for salaries and benefits and 15 percent for books and supplies, athletics, field trips, special programs and school maintenance and operations, including utility bills. Since the Arab oil embargo in 1973, energy bills have more than tripled, taking an ever increasing portion of that 15 percent and forcing cutbacks in special programs, books, supplies, and maintenance.

The inefficient use of energy compounds the problem of rising energy costs. The typical school, usually constructed during the 1950's and 1960's, was not built with energy efficiency in mind. Most schools are rambling, single-story structures with extensive glass areas. Very little insulation was used in either the roof or the wall. In a word, the building itself is energy inefficient.

What Schools Are Doing About Energy

There is hope and opportunity in this situation. Educators can combat rising energy costs by making the school more energy conscious and energy efficient. Many are doing just that.

School administrators across the country are establishing energy management programs. And, they are setting up energy management teams to identify ways to improve school energy efficiency. The team sets the goals for energy conservation and develops a plan for goal achievement.

The composition of these teams is very important. They include representatives from every aspect of the education community. Further, every member of the team has a specified responsibility.

Team Member

Responsibility

School Board and Superintendent

- Establish policy.

Energy Coordinator

- Coordinate the implementation of all conservation activities.
- Report to superintendent and school board.

Business Official

- Keep accurate records of energy expenditures and projected savings.
- Monitor billings closely for an early detection of energy inefficiencies.

Maintenance Engineer and Custodian

- Keep all mechanical and electrical equipment in good operating condition.
- Modify equipment and operating procedures to insure energy efficiency.
- Act as an early warning system for energy waste in the school building.

Outside "expert" from the local utility or the State Energy Office.

- Provide advice and counsel on technical matters.

Principal

- Set the tone of energy conservation in the school.
- Serve as a leader of his/her school's energy management team.
- Post energy conservation guidelines and operating procedures for the school.

Teacher

- Implement energy conservation in the classroom.
- Motivate students to learn about energy and energy conservation.

Students

- Assist in implementing and monitoring energy conservation activities.

PTA Representative

- Provide a liaison to the community and encourage broad support for energy conservation activities.

A valuable tool being used by energy managers is the energy audit. An energy audit is a complete survey of a building which identifies how energy is consumed and determines opportunities for energy efficiency.

The energy audit process is simple and consists of the following:

- Data gathering phase — Gathering of architectural, mechanical and electrical specifications, utility bills, and weather data.
- Preliminary analysis — Examination of all written data to find areas of energy waste.
- Building Examination — A complete, on-site inspection, usually conducted when the building is under full load conditions.
- Final analysis and report — Includes a detailed analysis of how a building uses energy, identifies opportunities for energy efficiencies and recommends appropriate action.

While some of the above-mentioned process may require analysis too complicated for the non-technical, non-engineering member of the school community, everyone can be involved. Much of the energy that can be saved is saved through the vigilance and cooperation of people. The observant person is invaluable in energy conservation activities.

In order to assist the non-technical person with becoming more aware of energy usage, SEED has developed a check list of typical school energy problems and possible solutions. The list is divided into three major categories: the building envelope, or outside surface of the building; mechanical and electrical equipment; and, special systems.

Problems

Building Envelope

Air filters in around windows and doors.

There are excessive glass and window areas.

There is insufficient roof insulation.

Excessive outside air is admitted through unit ventilators.

Solutions

- Caulk and weatherstrip.
- Replace window gaskets.
- Install vestibules at most used entrances and exits.
- Replace broken windows or doors.
- Plant wind break to deflect winds.

- Insulate the upper portion of windows.
- Reduce excess glassed areas, e.g., in corridors, entrances and upper portion of classroom windows.

- Add insulation when other major roof repair is required.

- Adjust dampers.
- Place a restricter, such as pegboard, over outside of the fresh air inlet to reduce the amount of air entering the unit ventilator.

Exhaust systems allow too much tempered air to escape.

- Place dampers on exhaust fans.
- Install timers on exhaust fans.
- Disconnect unnecessary exhaust fans.

Mechanical and Electrical Equipment

Rooms are too hot or too cold.

- Calibrate thermostats.
- Set thermostats at 68°F in winter.
- Repair any broken fans, valves and pumps in heating system.
- Keep doors and windows closed when system is operating.
- Clean or replace filters regularly.
- Check boilers to ensure they are operating properly.

Rooms have inefficient lights.

- Install high efficiency fluorescent lamps.
- Install high pressure sodium lamps in gyms.

Existing lighting is not well used.

- Turn off unneeded lights on bright days.
- Paint walls a light color to increase reflectivity.

Corridors and non-work areas are over illuminated.

- Disconnect unnecessary fixtures.
- Disconnect ballasts where fixtures have been removed.

Heating system operates too frequently

- Place system on timer so that it can be turned down or off when building is unoccupied.

Special Systems

Water heater temperature is too high.

- Reduce temperature setting.
- Install separate booster heaters in kitchen if necessary.

Operation of kitchen is energy inefficient.

- Avoid preheating the oven.
- Operate dishwasher and oven only when full.
- Clean refrigerator coils.
- Replace refrigerator gaskets when necessary.
- Do not leave exhaust fans running unnecessarily.

This list is not complete but does provide examples of what can be done. What is not addressed in this list is occupant or user education. People must be made aware that turning off lights and closing windows will make a significant difference.

Some schools are using "Energy Alert Cards" in every room to indicate the proper use of lights, windows, shades and temperature setting. Some schools are conducting public awareness programs in student assemblies and PTA meetings. Energy management teams contribute greatly to energy awareness. And, schools are finding that all of their efforts are working, for they are saving energy and money!

Teachers and Their Role in Energy Conservation

Teachers play an extremely important role in energy conservation for they are the first line of defense in each classroom. They ensure that windows and doors are closed during heating and cooling and that thermostats are repaired when needed. They are the "early warning system" for the maintenance and repair staff.

What Teachers Can Do

1. Keep doors and windows closed if building is being heated or cooled.
2. Turn off lights when rooms are unoccupied.
3. Close shades or curtains at night to help hold heat in the building.
4. Open shades on bright days to make use of natural lighting.
5. Arrange student seating to optimize natural and artificial lighting.
6. Do not adjust thermostats. Call the custodian.
7. Do not block heating/cooling vents with books, coats, etc.
8. Schedule parent conferences and extra-curricular activities to take advantage of the pre-heated or pre-cooled building.
9. Wear warmer clothing in the winter and cooler clothing in the summer.
10. Avoid using kilns and high electrical demand equipment during peak demand periods (10:30 a.m. — 1 p.m.).
11. Call the custodian or maintenance engineer whenever you spot a problem.

Further, it is through teachers that students are taught principles of energy, its use and its conservation. The remainder of this book, coupled with the proceeding background discussions, is designed to assist teachers in doing just that.



THE SCHOOL AS AN ENERGY CONSERVATION LABORATORY

If school buildings had been designed as instructional aids for teaching energy conservation, they would not have been more effective educational tools than the facilities which now exist! In fact, many school buildings are "naturals" for energy and energy conservation education, and, with little extra effort, can be used as the core of a dynamic teaching strategy by classroom teachers. Consider the gamut of applications.

What better illustrations of air infiltration exist for in-astria! arts students than the missing window caulking in the science room and the gap between the double doors at the end of the main hall? What better examples of lighting inefficiency can be found for physics students studying light than the incandescent lamps in the ceiling of the gymnasium and the dark blue and green cafeteria walls (the school colors!)? Where can social studies teachers find better examples of the effects of escalating energy costs on taxes, standards of living and curtailment of services (trimming the athletic schedule)? Where else can math teachers find so many relevant "story problems" and real-life data to graph than in the mechanical rooms (gas, electric and water meters; humidistats and temperature gauges for water heaters, swimming pools and air) which are usually considered off-limits to students?

The list of potential energy conservation lessons and school building applications is long and varied. Driver's education classes are concerned about efficient driving techniques and emphasize reduction in fuel consumption. These students could also calculate the annual fuel consumption of the buses serving their school or the fleet average passenger-miles per gallon index. And, they could study alternative patterns of school transportation.

What a timely opportunity for home economics students to learn about energy efficiency ratios (EER's) of appliances and the energy costs of food production and preparation (the school kitchen). Language arts, journalism and speech teachers could assign the writing of energy audit reports or conservation articles and the verbal presentation of the building's energy consumption status to the faculty, the parent-teacher-student association and/or the board of education. In short, there appears to be no better or more convenient tool for teaching energy conservation than the schoolhouse itself!

The matrix on the next two pages identifies some of the more obvious conservation applications of school building systems and traditional disciplines. Along the top are schoolhouse energy "systems". Identified along the left margin are typical school disciplines. Where row meets column, examples of conservation education activities are listed. It should be emphasized that these examples are activity **cores** — basic and unembellished. Some need to be "fleshed out" with school or other special data; all must be presented within the contexts of your traditional lessons and decorated with your style of presentation. They are offered here in the spirit of suggestion, and the list is by no means complete. You are encouraged to add to it.

The matrix presents many activities which demonstrate the applicability of the school energy system and conservation to traditional teaching. It is recommended that teachers reexamine their lesson plans with a view toward adapting them for use within this schoolhouse laboratory model. Implementation of the model in your school can provide an interdisciplinary approach to energy conservation education, utilizing the schoolhouse as the vehicle — and there is little or no additional cost for this exciting teaching tool!

	BUILDING STRUCTURE	LIGHTING	HEATING	VENTILATION / AIR CONDITIONING	HOT WATER
SCIENCE	- Study the insulating characteristics of various materials, including the new solar shield, by obtaining manufacturers' brochures and/or samples. - Determine feasibility of solar application for your building by studying: - Solar constant - Solar geometry - Geographic location - Your building's orientation - Cost - Write a short paper discussing the three methods of heat transfer: Conduction, convection, and radiation. - Determine how the following are factors related to conductive heat loss through a wall: - Temperature difference - Wall thickness - Resistance to heat flow - Area of wall	Determine the types and levels of lighting in various areas of the building. How much is enough? - Use a spectroscope to identify light sources. Draw the band spectra. - Construct a bar graph of the efficiencies (efficacies) and life times of various light sources. - Use a light meter to measure your classroom's natural illumination (with the lights off) at several times throughout the day. Graph your data.	- Design an experiment to determine the heating values for various fuels used in your school. - Investigate the heat storage capacity of various structural components of the school and their effects on the heating load. - Research the amount of heat delivered to a "classroom" by its occupants during different activities (e.g., reading/writing, walking about, calisthenics). How are heating requirements affected?	- Compute the area and volume of your school. Use English and metric units. - Ascertain the number of complete air changes per hour for your building. - Calculate the volume of air used to ventilate your school during one day. One school year.	- Measure the temperature of your cold water and hot water supply. - Determine the energy required to heat one gallon of cold water to the hot water supply temperature.
LANGUAGE ARTS	- Use a variety of media, such as the school newspaper, radio station or a video tape recorder to convince occupants to change their present energy usage patterns. - Write a column for the school or local newspaper about your school's energy conservation program.	- Research the effect of lighting on an individual's behavior. - Use light meters to determine the lowest lighting level at which the majority of the class can read a dittoed page. Repeat above with a page from a book.	- Conduct an opinion poll on the need for state or Federal regulations of building temperature settings; publicize the results. - Make a video tape or slide presentation entitled, "Our School's Heating System" for presentation to other classes. Include ways everyone can work together to save heating energy.	- Pretend that your local utility has requested voluntary electricity conservation. Role play the utility representative, a teacher, a parent, a student and the principal as they discuss pros and cons of turning off the school's cooling system at a special meeting. - If your school is air-conditioned, do a survey of the number of students and staff wearing sweaters or light jackets in the building to maintain their comfort. Publicize your results. - Use a video tape recorder to conduct a "student-in-the-hall" interview. Ask students for their opinions regarding the need for air conditioning.	- Pretend you are marketing a solar water heater for schools. Design a one-page advertisement extolling the virtues of your product. Make a video tape "commercial". - List the propaganda techniques you have utilized in your advertisement. Why did you use the ones you chose?
ARTS: FINE / INDUSTRIAL	- Determine composition of walls and roof. - Determine condition of caulking and weatherstripping. - Compare the advantages and disadvantages of various types of sealants. - Compare the advantages and disadvantages of various types of insulation. - Examine the effects of different site orientations and landscaping on your building. - Construct a wall cross-section showing the various insulating barriers for display. Calculate the U-Value for your wall.	- Redesign a typical classroom for more effective lighting control. Use time clocks, photocells, proper lamp placement, reflectors and switching. - Develop an attractive "Turn Off Lights" reminder for posting near switches. - Using a light meter, measure the reflectances from walls of different colors. Display your data in chart form.	- Tour your school's heating plant. Observe how it functions. Learn the operational and maintenance procedures necessary to keep it working efficiently. - Design posters to remind students and staff not to block heating vents or open windows during operation of heating or cooling equipment.	- Construct an instrument which will detect and measure air movement through corridors, grilles, vents and registers. - Design "air stops" to limit the movement of tempered air from conditioned to unconditioned areas.	- Design and construct a solar water heater with storage capability which utilizes the thermosiphoning process. - Test the effectiveness of various insulating materials for hot water components such as: - Water heater blankets - Hot water pipe insulation - Based on your results, recommend the most effective types.

CAFETERIA	POOL	EQUIPMENT
- List and research methods of food preparation which use renewable sources of energy rather than the traditional gas and electricity. - Would any of these alternatives be practical for use in your school now? Would they be practical in the Year 2000?	- Determine how much water must be added to your pool to make up for evaporation loss at various temperatures. - Investigate the origin of the 80-80-80 system (water temperature = 80°F air temperature = 80°F relative humidity = 80%). - Calculate the amount of energy required to raise the temperature of your pool water 1°F. Express your answer in kilocalories and BTU's.	- Suppose your school converts its major space heating equipment from oil or natural gas to coal. List the environmental trade-offs. - Repeat for conversion to solar and firewood.
"There is no such thing as a free lunch". Write a paper relating this statement to the energy involved in raising, transporting and preparing various foods for your school cafeteria. - Determine the kinds and relative amounts of trash and food waste discarded in the cafeteria. Estimate the amount of energy required to produce and dispose of this material during one school year. - Write a report about the use of trash/garbage to produce electricity in various cities.	- Debate the morality of a school swimming pool in an energy-short world. Video tape the debate. - Write a letter to the editor of your school newspaper justifying or criticizing your school's continued use of its swimming pool despite higher utility bills.	- Role-play the need for energy conservation regulations regarding electrical equipment labeling. Take the roles of the manufacturer, the consumer and a government representative. - Check the locations of school vending machines. In terms of energy efficiency, are these locations good? Why or why not? - Estimate the costs of operating these machines for the school year. Who pays this cost? Write a report summarizing your findings and conclusions.
- Design attractive posters which stress the need for wise use of our energy resources in the school. Post them in the cafeteria. - Design and construct working models of the following solar devices: - Hot dog cooker - Food drier - Oven	- Design and construct a scale model solar heater for your pool. Try it out. Collect and display your test data. - Investigate the efficiencies of commercially available models of solar pool heaters. - Using a container of water and simulating school conditions, judge the effectiveness of a pool cover in retaining heat and in reducing evaporative loss.	- Estimate the energy consumption of your wood, metal and automotive shops during the course of one class period. - Calculate the annual cost of operating this equipment. - Investigate the cost of operating your kilns for one school year. Explain how you would reduce these costs. - Call your local utility to learn about demand rates and time-of-day rates.

BUILDING STRUCTURE

LIGHTING

HEATING

VENTILATION / AIR CONDITIONING

HOT WATER

SOCIAL STUDIES

- Research the historical design and function of school buildings in 1776, 1870, 1920 and the present. Include pictures.
- Discuss the influence of energy fuel availability on school building design during the Industrial Revolution, Frontier Period and Space Age.

- Research the energy sources for lighting used in school through the ages.
- Investigate career opportunities in the lighting industry.
- Reducing lighting levels for conservation may have an effect on safety and security. Explain.

- Poll students regarding the feasibility of school calendar changes to save energy during the heating season.
- Compare current and expected fuel costs and their implications.
- Write a report on what the 1920 classroom, student clothes and school heating were like. Repeat, but use the Year 2000 as the benchmark.

- Research the career opportunities associated with the building's energy systems.
- Research the factors within our society which determine the need for air conditioning and ventilation. Have these needs changed over the last 20 years?
- Investigate local building codes to determine ventilation requirements for your school. Ask your maintenance supervisor how many air changes per hour occur in your building. Compare with code.

- Determine the factors in our society which encourage the excessive usage of hot water. How do these factors affect water and energy consumption in schools?
- Investigate the relative efficiencies of the following modes of heating water:
 - a. Solar
 - b. Electric
 - c. Natural Gas
 - d. Wood

MATHEMATICS

- Compute your school's:
 - a. gross area
 - b. door usage patterns
 - c. glass area
 - d. annual hours of usage
 - e. conductive heat loss through walls, windows (U-Values)
 - f. gross volume
 - g. unoccupied area as a % of gross area
- Using a stopwatch, time the closings of outside doors. Find the average closing time.

- Determine the building's total lighting wattage.
- Using an estimate of the annual hours of lighting and the total wattage, calculate the electrical energy consumption for the year in KWH.
- Estimate the total annual lighting cost.

- Obtain last year's heating fuel consumption data.
 - a. Construct a bar graph depicting consumption and cost.
 - b. Convert fuel consumed to BTU's
- Obtain last year's heating degree day data from local utility or weather bureau. Graph the data.
- Relate fuel consumption to severity of weather.

- Assume each student in your room releases 100 watts of heat energy while sitting quietly. Calculate how many BTU's must be removed every hour by your school's cooling system.
- Determine the difference in temperature between supply air and room air during the heating season. Repeat for the cooling season.

- On the average each school occupant uses two gallons of hot water per day.
 - a. Compute the number of gallons of hot water consumed per day in your school. Per year.
 - b. Make a list of ways to reduce hot water consumption without interfering with your normal school activities.

HOME ECONOMICS

- Design and create energy efficient window coverings such as drapes, curtains and blinds.
- Demonstrate the effectiveness of the following in reducing energy consumption:
 - a. Carpets
 - b. Wall coverings
 - c. Wall/ceiling colors
 - d. Cleanliness of walls
 - e. Storm windows
 - f. Fireplace doors

- Design the proper placement of tasks to take advantage of natural and artificial lighting in the home economics room and/or kitchen.
- Determine proper lamp types and sizes for performance of home economics tasks.
- Compare the cost of various lamp types and their expected life spans. Use manufacturer's catalogs.

- Find out the relative energy savings associated with various thermostat set-backs: night vs. day, weekends, and vacations.
 - Investigate the thermal properties of synthetic and natural fibers.
 - Design posters which "teach" students how to dress for school during the heating and cooling seasons.
- *Heating season refers to those periods when heating equipment is in operation; similarly, cooling season refers to those times when cooling equipment is operating.

- Determine whether kitchen air is recycled or exhausted to the outside.
- Investigate the potential for other types of heat recovery systems for your school kitchen.
- Plan landscaping for your school which utilizes nature as the "air conditioner".

- Measure the temperature of hot water used for dishwashing. Decide whether adequate. Are booster heaters used?
- Determine the maximum flow rate of hot water in gallons/minute for the kitchen sinks.
- Make a list of devices which can reduce the flow rate of hot water. Evaluate them.

CAFETERIA	POOL	EQUIPMENT
• Using today's school lunch menu, draw a picture of all of the energy conversions required to produce, transport and prepare each food for your lunch. • Can any of the traditional energy sources you drew be replaced by renewable sources? Which?	• Compare the operational cost of your school's pool with the recreational value obtained. • Survey the student body, faculty and community to determine the range of values associated with school swimming pools. Publicize your results.	• Gather data to determine whether your school has increased, decreased or stabilized its electricity consumption over the last two years. Display your data. • If your school had to curtail drastically its electrical energy consumption, what equipment could be turned off and still maintain a good instructional program? • Which equipment would be impossible to do without? Explain.
• Estimate how much gas and electricity are used for food preparation. Compare fuel consumption before and after kitchen use (read gas and electric meters). • Calculate the average energy cost in BTU's per meal served.	• Compute the volume of your school's swimming pool in cubic feet, cubic meters and gallons. • Convert the volume of your pool into kilograms by multiplying by the density of water (1000 kilograms/cubic meter). • Determine the amount of heat (in Calories and BTU's) which your pool would release if cooled to 50°F (10°C).	• Select three kinds of electrical equipment found in your school. From name plate data and an estimate of annual usage, calculate the electrical consumption in kilowatt hours. • Using the current cost per KWH*, compute the annual operating costs for this equipment. * Check with your local utility.
• Check to see if the following practices are utilized in your kitchen: a. Preheating of cooking equipment b. Frequent opening of refrigerator/cooler/oven doors. c. Routine cleaning of cooling coils and burners. • Discuss the pros and cons of each practice. • Practice techniques of efficient food preparation.	• Compute the energy consumed in drying your hair (after swimming) with an electric hair dryer (1200 watts) for 15 minutes. • Using the current cost* of electricity in your community, compute the cost of drying your hair. * Check with your local utility.	• Plan the correct placement of heat-generating appliances in the home economics room. Try various arrangements for maximum energy efficiency. • Study the EER ratings of various home economics appliances to determine their relative efficiencies. • Make a list of energy saving cooking techniques and devices. • From an energy perspective what are the advantages of microwave ovens? Investigate commercial models.



CONDUCTING A STUDENT ENERGY SURVEY

A TEACHER WORKBOOK

In the rush of playing "catch-up" during the baby boom of the 1950's and 1960's, the design and construction of our schools emphasized space over energy efficiency. Energy was cheap in those decades and having enough classroom space was essential. The walls of glass, the banks of lights, the over-sized equipment, and the rapid construction during that period are now millstones around the necks of school districts.

The past cannot be changed, but the present and future can! All occupants in the schoolbuilding can take responsibility for more energy efficiency. Administrators, teachers, staff personnel, and students can pivot the axis toward accountable, judicious energy usage.

Conducting a Student Energy Survey of a school building may appear to be an overwhelming task to many educators. At first glance it would seem to require a technical expertise foreign to most teachers. Not true! Although some sophisticated energy equipment found in your school might require more time to understand than others, the greater part of the Student Energy Survey requires only common sense and application of readily available knowledge.



The Magic of Energy Surveys

Students can develop an energy awareness and some expertise in the field of energy conservation. Students, with professional guidance, can perform an energy survey and follow-up analysis. This expertise can be shared with all in the school to create a unified commitment to energy efficiency.

For the uninitiated, an energy survey is a physical tour of a building to determine how the building utilizes energy. The survey, if done well, identifies energy saving opportunities and suggests methods to accomplish each one. This information is recorded and the results analyzed for possible corrective action. The word "survey" is used deliberately here to distinguish the student activity from an energy audit, a more technical analysis of a building's energy usage.

Involving the students in a school energy conservation program can produce positive results. One school district in Wyoming assigned students and staff to every building energy team. Together they reduced the electrical bill by 50 per cent in one year. In a Colorado district, the eighth grade curriculum requires every science student to participate in a school energy audit. Student participation, awareness and cooperation can help reduce energy usage. The dramatic results have an observable and measurable positive effect on the school climate. There is a "little magic" in saving; perhaps this is why we are a nation of collectors. Energy conservation can utilize this touch of magic.

Developing an energy ethic together can provide a school community with a real opportunity for caring, sharing and learning. And this is what education is all about!

In The Beginning

Student research in energy conservation, as in any other subject, is a good place to start. Although the grade level is a consideration, the methods and materials presented here can be modified for use from grades 6 through 12.

Begin by inviting an architect, mechanical engineer or representative of your local utility company to speak to the class. Senior citizens knowledgeable in energy management also make excellent consultants. A letter to the U.S. Department of Energy or a trip to the State Energy Office will generate numerous pieces of literature on energy conservation, useful not only in the school but also at home.

This research period is also a good time to show the SEED film, *THE FOURTH R*. Although the film is intended for older audiences, it displays a mini-audit in a brief, concise way that has been effective with junior and senior high school students.

Conducting The Survey

Before conducting an energy survey, review with students the set of questions and activities in the Student Energy Survey. Ask each student to respond to the questions during and after the energy tour. It is suggested that the students carry the survey forms on the tour for quick reference and review.

The teacher is encouraged to have the building tour conducted by a knowledgeable energy "expert" (from the local school district, utility, or community) who is familiar with the building. Encourage the custodian to join the tour so that he feels part of the "team". The teacher, custodian or "expert" should plan the route for the survey, and carry a set of master keys to open doors to the many areas they will visit. Also, light meters and mercury thermometers are essential. Allow time on the tour for questions.



A reasonable place to start an energy audit is the outside of the building. Many students pass through the entrance of their schools without really noticing the building structure. This survey is an ideal opportunity to sharpen their awareness of a part of the world where they spend a significant portion of their lives.

As the students proceed inside the building, a new world of energy awareness should emerge. The most noticeable observations will be the temperature change and the lights. Students will become alert to conditions affecting instruction they may have never noticed. After spending a few minutes in the cafeteria, kitchen, the boiler/furnace room, and other areas of the school not usually accessible to them, students grasp the complexity of the educational system and expand their energy usage awareness and knowledge.

After the energy survey has been completed, the class should have many unanswered questions. The teacher can request an energy "expert" to answer these questions, or suggest that the students do team research to find answers. Discussion and related projects also will stimulate a commitment to effect responsible energy usage.

After The Tour

After the students have returned to the classroom and the survey form is completed, it is time to review or "debrief". The "expert" can respond to questions, analyze results, and discuss possible energy conservation options.

Then the class can prepare a report for the principal or energy team. This report can be presented in written form or orally.

Tips for the Teacher - Things To Observe While On The Tour (Keyed to Student Survey Form)

I. A Look At The School From Outside

Most of us have had sufficient experiences with the exteriors of buildings to answer the questions in this section with little additional technical expertise. A telephone call or a quick visit to the individual that has the building's blueprints would answer the following key questions:

1. Do the roof and walls have insulation? How much?
2. Are the exterior lights controlled manually or by time clocks? The building engineer then can tell you their activation periods.

A quick survey of the condition of the building's exterior can be made while establishing the route the students will follow.

- A. When starting the energy survey outside the building note the configuration of the building. Is it shaped like an E, H, T, rectangle, square, etc.?
- B. What direction does the front of the building face? What direction do major entrances face? Which way does the prevailing wind blow? Does the building have any protection against prevailing winds, such as trees, or does it need any?
- C. Note approximate percentage of wall area occupied by windows. What direction do windows face? Are they tight-fitting? Can they be opened? If they can, are they usually open during heating/cooling seasons?

- D. Could the windows be double-paned or replaced by insulated walls? How would this affect internal illumination patterns? Note any cracked or broken windows. Plastic windows have the same heat loss as glass windows.
- E. Do the exterior doors seal tightly? Are they out of alignment or do they close too slowly. Should double or vestibule doors be installed? What is the temperature difference between outside and inside, and how does this difference affect heat loss? When doors are open is there a "wind tunnel" effect in the halls?
- F. Are the exterior walls in good condition and do their colors affect energy usage?
- G. Are security lights efficient and effective? Do they actually reduce vandalism? What would happen if they were all turned out? Note what time they go on and off.

II. A Look Inside The School

Use the light meter while establishing the student route, to observe and record existing lighting levels. The temperature readings may not be representative since the time of day and outside weather conditions usually affect them. These conditions may be different from those observed during the actual student survey.

Note: Ordinary fluorescent lamps are 4 times more efficient than incandescent bulbs. The high efficiency fluorescent lamps are 14 percent more efficient than the older models. It is important to know that ballasts should be disconnected in fixtures where fluorescent tubes have been removed. Ballasts are electrical transformers used in every type of lighting system except incandescent. They will continue to use electricity even if the tubes are removed. The custodian or other maintenance personnel will be able to help with this question.

Cleanliness is important. Dirt on any exterior glass or plastic fixture lens can reduce natural lighting an average of 20 percent. An extremely dirty window may become an unwanted shading device.

- H. When the students are inside, have them record light levels using a light meter, and note temperature levels using a mercury or digital thermometer. Be sure body heat is not allowed to affect readings. Light readings are most realistic if made at table or desk-top level. Although it is not necessary to visit every area of the building, it is important to select representative classrooms, rest rooms and corridors. Observe other areas from hallways.
- I. Be sure students record where lights are unnecessary or too bright. Also look for energy waste where lights have been left burning in unoccupied areas. Discuss how the colors of the walls affect light levels. Students could calculate how much energy would be saved if energy-saving fluorescent tubes (35 watt) were installed throughout the school. If fluorescent lamps have been removed, have students check to see if the ballasts are disconnected. Ask why this is important.
- J. Students will be interested in knowing if the light switches are conveniently located and used. Remind students to observe how the natural light is utilized. Are window shades used to optimize natural lighting?
- K. Ask the students' opinion concerning skylights. Are the lights, fixtures, and skylights clean? Discuss how much dirty windows, fixtures and lamps affect natural lighting.

III. Cafeteria/Kitchen:

Prior to the survey and at his/her convenience, meet with the individual in charge of the kitchen to discuss the special equipment and the number of hours it is used. Explain the purpose of the survey and request assistance when the students visit this area. If proper working attitudes are established, the students not only will be made aware of the kitchen's energy use pattern but will develop a greater respect for those individuals preparing and serving food in their school.

- L. When visiting the kitchen area, have the students ask the supervisor about pre-heating practices, baking schedules, and the types of energy-using equipment necessary to produce the meals.

IV. Exhaust Fans:

Exhaust fans can be energy wasters, not because they use much energy themselves (they actually use relatively little), but because they expel cooled or heated air to the outside. And they may do this 24 hours per day, 365 days per year!

Many exhaust fans have no dampers (air flow adjusters). Even when the fans are inactive, they allow tempered air to escape to the outside via the "chimney effect." Some exhaust fans have been found operating backwards.

Have students count exhaust fans as they tour the building. Check industrial arts area, kitchens, rest rooms, and auditoriums. Make note of the size, operating times, and methods of fan control.

V. Hot Water For Washing:

If electricity is used for heating water, the heater should only operate during late afternoons, evenings, or at night in order to avoid peak demand periods and excessive demand charges. If hot water is needed during peak demand periods, the school may consider installing smaller, separate water heaters. Electric bills include an energy charge and a demand charge. The former is based on consumption of fuel required to generate electrical energy; the demand charge is directly related to the power required by the building. Whether the building has an electrical demand meter can be determined by examining the meter or the electric bill for columns labeled "Measured Demand" and "Billing Demand."

Do water faucets clog or have excessive pressure? Students can consider whether water restricters would reduce waste. What hot water temperature is required by the local health code? How is the water heated? Are water pipes insulated? Does the water heater need to be relocated?

VI. Heating/Cooling System and

VII. Heating Control Room:

Before planning this segment of the instructional tour, make an appointment with the individual in your district who supervises the maintenance of the heating/cooling equipment. The appointment should not last over 45 minutes, but should include a personal tour of the heating/cooling room(s). This individual can provide all of the information needed for this section of the energy survey. For example:

1. The type of installed heating or cooling system, hot water, steam, forced air, univent, etc.
2. How the basic system works and the energy source(s) required.
3. Any required maintenance procedures and problems areas.
4. Location of the time clocks and how and what they control.
5. Why this type of heating/cooling system was chosen and the date of installation.

How does the heating/cooling get to the classroom or hallway? How does the return air get to the heat source? Have students note if the vents or heating elements are clean and unblocked. Have them judge whether the thermostats are properly located and controlling the temperature. Are the thermostats too easily "adjusted" by unauthorized persons?

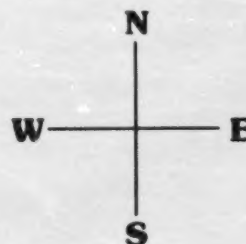
Visiting the boiler/furnace room and listening to an explanation/demonstration of how these systems work can be very informative. Have the custodian demonstrate the clocks, the night set-back system, and other control features that make the heating/cooling unit(s) operate more efficiently. Request that students always be alert for cleanliness. Dirt is an insulator, but not a desirable one.

STUDENT SCHOOLHOUSE ENERGY SURVEY

Student's Name _____ Grade Level _____ Room Number _____
 School _____ Number of Students _____
 Length of School Day _____ Hours for Cleaning _____
 Monthly Heating/Cooling Costs _____

I. A Look At The School From Outside

- A. Draw an outline of the school in the space below.
- B. What direction does the school entrance face? _____
 Which way does the wind usually blow? _____
 What protection does the building have? _____
- C. Does the school have many windows? _____ Many _____ Some _____ Few _____
 What percent of the wall area is windows? _____ %
 How many windows face South? _____ North? _____ East? _____ West? _____
 Can the windows be opened? _____ Are the windows tight fitting? _____
 Should any windows be double paned? _____ Where? _____
- D. Could energy be saved by replacing selected windows with insulated walls or insulating material? _____
 Where? _____
 Are any windows cracked or broken? _____ How many? _____
- E. Do the outside doors fit tightly? _____
 Do doors need weatherstripping? _____
 Should there be double doors at any of the entrances? _____
- F. Are the outside walls in good condition? _____
 Of what material are the outside walls made? _____
 Is there insulation in the walls? _____ Roof? _____
 How does the color of the walls/roof affect energy usage? _____
- G. Is the security lighting effective in preventing vandalism? _____
 How many hours are these outside lights turned on? _____



II. A Look Inside The School

H. Note the following for each area listed below:

Area	Color of Walls	Lighting level in Footcandles	Type of Lighting			Temperature
			Incandescent	Fluorescent	Other	
Halls						
Offices						
Classrooms						
Gym						
Cafeteria						
Library						
Other						

How does the color of the walls affect lighting? _____

I. List any areas of the school where there are unnecessary lights: _____

List any rooms where the lights appear too bright: _____

List any areas where lights appear too dim: _____

Does the school use energy-efficient fluorescent lamps? _____

Mercury vapor? _____ Other? _____

If fluorescent lamps have been removed, are the energy using ballasts disconnected? _____

J. Are there areas where lights have been left on when no one was present? _____

List: _____

Are the light switches located for easy use? _____

Is the natural light from windows used properly? _____

K. How does keeping the following clean affect energy usage?

Windows _____

Light Fixtures _____

Skylights _____

III. Cafeteria/Kitchen

L. What energy sources are used in the kitchen:

Natural gas _____

Electric _____

Other _____

List kitchen items using energy (not human) and hours they are used:

Item	Hours Used
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Is the kitchen well arranged to use energy efficiently? _____

Is heat producing equipment located next to cooling equipment? _____

IV. Exhaust Fans

Check the hours exhaust fans operate in the following areas:

Rest rooms _____ Kitchen _____ Art _____

Industrial Art _____ Other _____

How are most exhaust fans controlled? _____

V. Hot Water For Washing

What is the temperature of the hot water as it comes from the tap in:

Rest rooms _____ °F (_____ °C)

Cafeteria/Kitchen _____ °F (_____ °C) $C^{\circ} = 5/9 (F - 32)$

Dishwasher _____ °F (_____ °C) $F^{\circ} = 9/5 (C + 32)$

Do any faucets drip? _____ Where? _____

Measure the gallons per minute from a faucet _____

How many BTU's are used per hour by the water heater? _____

If electricity is used to heat water, does the heater only turn on at night? _____

VI. Heating/Cooling System

Do the thermostats read/control the room temperature accurately? _____

Are the thermostats well placed? _____

What is the night thermostat setting? _____ °F (_____ °C)

What are the day settings of thermostats? _____ °F (_____ °C)

Is there good air movement from the heating/cooling equipment? _____

Is untreated outside air used for cooling when possible? _____

Are the heating/cooling elements kept clean? _____

Do the little used areas have lower thermostat settings for heating? _____

VII. Heating Control Room

If the school is heated by a boiler or furnace, what are the BTU's used per hour? _____

Does the heating unit(s) appear clean and well maintained? _____

When was the last time the flame/air settings had an efficiency check? _____

Is it posted? _____

Is the time clock on the right day and time? _____

What hours does the time clock allow the heating system to operate on day setting? _____

Night setting? _____

What fuel is used to heat the school? _____

VIII. Putting It All Together

After surveying the school and answering the above questions, it is time to look at what you have discovered.

(1) Please list good energy management practices that have already been implemented in the school:

(2) Please list places you observed energy being wasted. Also state a possible solution for each item observed.

DEBRIEFING THE STUDENT ENERGY SURVEY

Do not underestimate the importance of the debriefing session for it provides not only a discussion of responses to the survey form but also serves as a device for the enhancement of relationships among students, faculty and staff. In addition, it provides a mechanism for activity closure.

Following the completion of the energy survey and the Student Energy Survey forms, students should be given an opportunity to discuss their observations and concerns with the teacher, each other, and individuals familiar with the building systems. The custodian, maintenance supervisor or food service manager should be invited to attend the final debriefing session.

The following outline is recommended for use and will take approximately one to two class periods to complete.

1. REGROUPING FOR THE REPORTS (THIRTY MINUTES)

By row numbers students are assigned the major building "systems" as indicated by the bold headings in the Student Energy Survey. For example:

Row No.	Assignment
1	I. A Look At the School From Outside
2	II. A Look Inside The School
3	III. Cafeteria/Kitchen
	IV. Exhaust Fans
4	V. Hot Water For Washing
5	VI. Heating/Cooling System
6	VIII. Heating/Cooling Room

Item VIII, Putting It All Together, is reserved as the culminating activity in the debriefing.

Students, now regrouped by rows, are asked to develop cooperatively a one-page written statement which summarizes the conditions of their assigned building system. They should select a spokesperson to read the statement to the class.

2. PRESENTING THE GROUP REPORTS (THIRTY-FIVE MINUTES)

Each student presenter reads the group summary to the class. This "formal" presentation, including questions and answers, should not exceed five minutes. Students should listen carefully since this information will be the basis for their recommendations and will be included in the Energy Survey Report.

3. COMPLETING THE ENERGY SURVEY REPORT (FIFTEEN MINUTES)

Either as a class activity or a homework assignment, the Energy Survey Report should be completed by each student and submitted to the instructor for evaluation. Please refer to the Energy Survey Report for details.

4. COMPILING THE CLASS DATA (THIRTY MINUTES, NON-CLASS TIME)

It is recommended that either the teacher or two or three students tabulate the Technical Ratings (Part 8 of the Energy Survey Report) and list different recommendations in descending order of frequency. Either an overhead transparency, a ditto master or the chalkboard may be prepared for presenting the class data.

5. PRESENTING THE CLASS DATA (THIRTY MINUTES)

The teacher or students should present the organized data to the class and guests for their reactions and responses. Sufficient time should be allowed for a thorough group discussion of student recommendations and their potential implications for energy conservation. Encourage guests to contribute their expertise. It will be a welcome and invaluable addition to the discussion.

Copies of the class recommendations should be made available to the administration and/or other staff members for further consideration and possible implementation. If appropriate, get on the agenda for the school board meeting and present student findings. Student enthusiasm about school energy conservation can contribute greatly to your school's energy program. However, remember that all of the financial and staff resources may not be available to implement your recommendations immediately.

6. PUTTING IT ALL TOGETHER:

It is recommended that the class review the section which includes the Student Energy Survey and the information used to fill out the Student Survey Form. Now respond to the following statements.

1. Please list good energy management practices that have already been implemented in the school.
2. Please list places you observed energy being wasted. Also state a possible solution for each item observed.

You may have discovered an area of energy waste and not identified a solution. A telephone call to your school plant manager, the local utility or the State Energy Conservation Office should provide a reasonable response.

THE ENERGY SURVEY REPORT

A. Administrative

1. Name of Student _____
Class _____
Teacher _____
2. Name of Building Surveyed _____
Address _____
Date Building Surveyed _____
Time of Day of Survey _____
Ambient (Outside) Temperature _____ °F _____ °C

B. Technical Ratings

Instructions: Please assign a rating to the following building systems which you have observed during your energy survey by circling the appropriate numeral. Low numbers represent conditions of energy inefficiency; high numbers represent conditions of wise energy use.

After you have decided upon a rating, explain your decision. Please list specific reasons for your choice.

1. Building Structure

Rating: Low 1 2 3 4 5 6 7 8 9 10 High

Explain: _____

2. Lighting

Rating: Low 1 2 3 4 5 6 7 8 9 10 High

Explain: _____

3. Cafeteria/Kitchen

Rating: Low 1 2 3 4 5 6 7 8 9 10 High

Explain: _____

4. Exhaust Fans

Rating: Low 1 2 3 4 5 6 7 8 9 10 High

Explain: _____

5. Hot Water for Washing

Rating: Low 1 2 3 4 5 6 7 8 9 10 High

Explain: _____

6. Heating/Cooling System

Rating: Low 1 2 3 4 5 6 7 8 9 10 High

Explain: _____

C. Overall Energy Efficiency Rating

Please average the ratings assigned above to determine the overall building score. Write average in space below.

(_____)

Overall Rating

D. Recommendations

Please make five (5) recommendations that, if implemented, would make the building more energy efficient.

1 _____

2 _____

3 _____

4 _____

5 _____

The above ratings and recommendations represent my best judgment.

Signature of Student

Date

GOING BEYOND THE SURVEY

Inside the Classroom

In those classes with exceptionally alert students, a successful activity has involved the design of an energy efficient schoolhouse. A reinforcement of the learning activity follows when an architect or engineer analyzes the plans with the class.

Other activities that can extend the use of the school as an energy conservation laboratory are:

- Suggest students research the addition of a solar heating system to the school to discover if it is practical and efficient.
- Have students develop check lists to grade members of the student body and staff on energy management habits.
- Have the students design reminders to aid occupants in turning off lights.
- Have student teams read the electric or natural gas meters twice a day to record usage. A two-week experiment will indicate how much is used days, nights, and weekends. It is suggested an expert explain how meters are read.
- Assign a group of students to research and report on what their classroom, clothes, and school activities would be like if they lived in the early 1900's. Another group could do life in the year 2010. Relate how energy usage affects standards of living.
- Have students secure copies of utility bills for the school and graph usage patterns over the past two years on a monthly basis. Students could graph costs for this period and display findings in a busy hallway or other areas where they will be easily observed.

Additional activities will emerge as you proceed through the energy unit, both through your imagination and student enthusiasm.

Outside The Classroom

The following five projects provide examples of opportunities to extend the Student Energy Survey beyond the scope of the schoolhouse.

1. "HOW OUR SCHOOL USES ENERGY" — A SLIDE PRESENTATION

After the Student Energy Survey has been completed, students can adapt the information into script form. Student photographers can take slide photographs of the building's energy systems, depicting examples of energy use and misuse which will coordinate with the script.

The student production can then be presented to other classes, faculty, the Board of Education and/or community groups. A show of this type can be especially helpful if examples of good home energy management are included.

2. STUDENT ENERGY WEEK

Students and staff can plan and develop an exciting school-wide "Energy Week". For example, the following components can be included:

- a. Speakers from energy related industries to discuss emerging energy technologies, e.g., shale oil, coal gasification, tertiary recovery, etc;
- b. Alternative Transportation Day, e.g., walking, car pools, roller skates, etc.;
- c. Reduction of heating and lighting levels to dramatize potential life style changes;
- d. Fashion shows which illustrate our dependence on petroleum-derived synthetics and the available options;
- e. Energy-conscious meals provided by the cafeteria;
- f. Disconnection of the vending machines; and,
- g. Nonuse of petroleum-derived instructional materials, e.g., transparencies, ditto fluid, etc.

3. LOCAL GOVERNMENT BUILDING SURVEYS

Utilizing the Student Energy Survey forms, students can tour local government buildings to determine energy usage patterns. Results of these surveys can be presented to the mayor, city council and/or citizen groups.

4. COMMERCIAL ENERGY FAIR

Local merchants can be invited to display alternative energy/conservation devices in a designated area of the school. Parents and interested citizens should be encouraged to share ideas and observe the exhibits. Various weatherization techniques can be demonstrated by students or professionals. Also, student projects can be displayed.

5. RADIO PROGRAMS

Students can be encouraged to produce a weekly energy conservation radio spot which can be pre-taped and aired on the local station. This type of program might include energy conservation tips, renewable energy technologies and interviews with energy experts and politicians.



ENERGIZING YOUR CURRICULUM

Energy has always been a hidden theme in most traditional disciplines. The current attention to energy underscores the need to rediscover the hidden energy components in existing curricula. This section will assist the teacher in identifying those components and in designing challenging activities which focus on them.

First, list the traditional concepts considered essential in the teaching of a subject area. Then, for each concept identify and write down the hidden energy component. Finally, develop an activity (or modify an existing one) which emphasizes this hidden energy component. Consider the following example of a typical social studies lesson.

Lesson Title: The Discovery of America

Time Required: Variable

Traditional Concept: A few brave individuals have risked lives and fortunes to expand knowledge, technology and wealth.

Hidden Energy Component: The redesign of boats, the invention of the compass and the more sophisticated design and use of sails allowed early explorers to more effectively convert a form of solar energy (wind) into motion.

Lesson Objective: To demonstrate how advances in technology and wind energy conversion helped to make these discoveries possible.

Materials Required:

1. World map showing prevailing winds and currents
2. Various models of sail designs
3. Cross-sectional pictures of sailing vessels

Procedure:

1. Assign a short report which researches the kinds of energy sources used on sailing vessels during this period.
2. Ask students to build simple sailboat models using a variety of sail designs. Test the models for navigational effectiveness.

Evaluation: Based on the quality of sailboat models/designs submitted

Follow-Up Activity: Report on other applications of solar energy during this period.

The traditional lesson, The Discovery of America, now has been modified to reflect its hidden energy component.

Choosing one of the traditional concepts identified as essential in teaching a subject, use the following format to develop an original activity, or to modify or refine an existing lesson to reflect its hidden energy component(s). Some example lessons, prepared by teachers in the Community Resources Workshops of Racine, Wisconsin, are included for your examination on the following pages.

FORMAT FOR ENERGIZING YOUR CURRICULUM

LESSON TITLE:

GRADE LEVEL:

TRADITIONAL CONCEPT:

TIME REQUIRED:

HIDDEN ENERGY COMPONENT:

LESSON OBJECTIVE:

MATERIALS REQUIRED:

- 1.
- 2.
- 3.
- 4.

PROCEDURE:

- 1.
- 2.
- 3.
- 4.

EVALUATION:

FOLLOW-UP ACTIVITY(S):

- 1.
- 2.

ENERGIZED LESSON PLANS

Lesson Title:	Post Office	Grade Level: 2
		Time Required: 2 — 4 weeks
Traditional Concept:	The mail must go through; neither rain, nor snow, nor sleet, nor hail shall keep the mailman from his appointed route.	
Hidden Energy Component:	Through time and technology, we have changed the energy source for mail delivery from human to animal to wood to fossil fuels.	
Lesson Objective:	To demonstrate how advances in technology have expanded the service worldwide.	
Materials Required:	Cardboard post office Posters, films, kits depicting evolution of the post office Maps and/or globes Articles from books and magazines	
Procedure:	Set up a post office in February (coincide with Valentine Day). Through audiovisuals and discussions, show how mail was moved historically and trace its movement. Write a letter to a classmate, mail it from the local post office and see when it is delivered. Collect stamps and post cards and place on a world map.	
Evaluation:	Children discuss what would happen to mail delivery if there were no fossil fuels.	
Follow-up Activity:	Visit a post office. Draw a mural depicting the progression of mail delivery from the runner to the jet plane.	

Lesson Title:	Draw and Construct a home	Grade Level: 4 — 6
		Time Required: Indefinite
Traditional Concept:	Designing and Building a Dream House	
Hidden Energy Component:	Using design and material to construct an energy efficient home	
Lesson Objective:	To explain principals of design and construction	
Materials Required:	Students bring materials from home, including orange juice cans, boxes, toothpicks, cans, foil, cardboard, and plastic wrap. Glue Stirrers, paper, pencil and rulers Clay, construction paper sponges, pipe cleaners, sand and popsicle sticks	
Procedure:	In September, design and build a dream house with a partner. Discuss dream houses. Using pictures and slides, discuss building design and construction procedures. As the school year progresses, investigate the construction design and materials used in building energy efficient homes. Redesign and reconstruct the dream house so that it becomes energy efficient.	
Evaluation:	Compare and discuss the dream house versus the energy efficient home.	
Follow-up Activity:	Set up a display for school Energy Fair exhibit Exhibit for the PTA Survey of own home to look for energy saving opportunities	

Lesson Title:	Farming	Grade Level: 3 — 4
		Time Required: 4 days minimum
Traditional Concept:	Marketing produce	
Hidden Energy Component:	Use of rivers and their importance	
Lesson Objective:	To trace the various kinds of river transportation used to move produce, goods, and equipment.	
Materials Required:	Maps of your state Visual aids Guest speaker Science teacher demonstrating how steam is made and used	
Procedure:	In groups or as individuals, trace routes from farm areas to the markets. Using transparent overlays, show the type of produce in each farm area. Perform time studies to show transportation changes and development. Have someone from the museum come to demonstrate and discuss river transportation, how it has changed and its role today. Have science teacher demonstrate how steam is made and used.	
Evaluation:	Observation of student participation.	
Follow-up Activity:	Build a model barge.	

Lesson Title:	Industrialization — Railroads	Grade Level: 5 — 6
		Time Required: 3 weeks
Traditional Concept:	Men of foresight risked lives and money to unite the country from East to West.	
Hidden Energy Component:	Design of the locomotive engine Laying of railroad track and use of dynamite Conversion of coal and wood into energy for locomotive	
Lesson Objective:	To demonstrate how technological advances in the use of coal and wood enabled the expansion of America.	
Materials Required:	Maps indicating possible routes for track and fuel sources Models of various types of steam engines Pictures of locomotives in use during the early days of the railroad Graphs illustrating how coal and wood are converted into energy	
Procedure:	Divide class into four groups. Assign one group to research and map feasible railroad routes and sources of energy from coast to coast. Assign a second group to gather pictures and sketches of locomotives from the first to ones in use today. Assign another group the task of designing a sketch which demonstrates how an engine converts coal or wood into energy. Assign the last group the task of building a scale model of a working locomotive.	
Evaluation:	Product of projects Oral and/or written presentations to the entire class	
Follow-up Activity:	Scale model of famous railroad depot, including tracks, train, station, and surrounding area. Demonstrate through reports or panel discussion the economic effects of construction of the railroads.	

EXAMPLES OF ENERGY EDUCATION PROGRAMS

ENERGY RIDDLES AND JOKES

Source: Beverly F. Wu
Lakeview School
Oakland, California

Class: Language Arts
Grades: 1-3
Time: 2 weeks to 3 months

Concept: The study of energy can be educational and entertaining.

Objective: To teach students about energy and energy conservation using jokes and riddles.

Materials: Several joke and riddle books
Paper, pencil, crayons

- Procedures:**
1. Begin unit by studying joke and riddle books (in your classroom library), which are popular with your class.
 2. Have children bring joke books from the library and their homes to share with the class.
 3. Each time a child discovers an energy related joke or riddle, have the child share it with the class.
 4. Write down the joke or riddle and give credit to the child who found it. The same child might also illustrate the joke or riddle in the finished book.
 5. Encourage children to be creative in finding jokes. Have them ask friends and family members. Suggest they look in the newspapers and magazines. Have some children make up their own energy related humor.
 6. Determine with your class the numbers of riddles and jokes you want in your finished book. Selecting a title for the book may influence the number you determine.
 7. Suggested criteria for riddles and jokes for your finished book might include:
 - relating to an energy source;
 - relating to an energy user;
 - using energy as a related word;
 - referring to an energy source or an energy user; or
 - referring to an energy saver.
 8. Take field trips to oil refineries, salt flats, environmental living projects, and utility companies to add stimulation and interest to the project.
 9. Let the book be a natural outgrowth of your studies on energy and of your students' personalities.
 10. Have each child contribute to the book either by finding a joke or riddle or doing an illustration.
 11. Display the finished book at a science or energy fair and at Parents' Night at your school.

CONTROLLING RATE OF CONSUMPTION OF COAL

Source: Sylvia Sather
Whiteman Elementary School
Denver Public Schools
Denver, Colorado

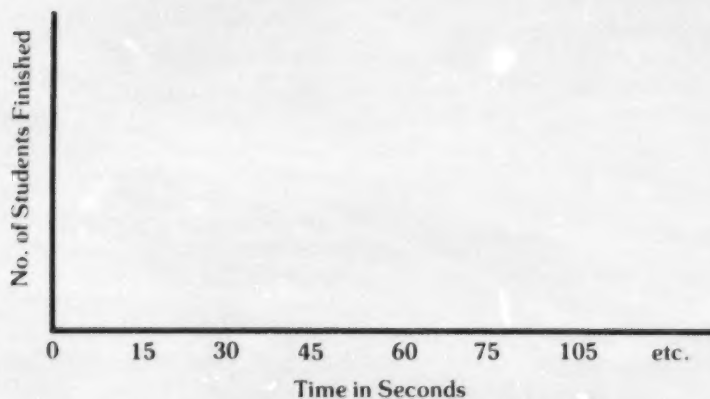
Class: Science
Social Studies
Mathematics
Grades: 1-3
Time: 30 minutes

Concept: Resources will be available for a longer period of time if we control the rate of consumption.

Objective: To analyze the effects of conservation compared to unlimited consumption.

Materials: Two chocolate chip cookies per child
Clock or timing device
Chalkboard for timegraphs

- Procedures:**
1. Each child is given a cookie.
 2. When the signal is given the children will begin eating the cookie. They **MUST** raise a hand when they finish. Count the hands that are raised every 15 seconds until all cookies are consumed. At the last count all hands should be raised. Once the child raises his/her hand, he/she must keep it up.
 3. Create the graph. Indicate how many students are finished eating every 15 seconds.



4. Talk (analyze) with the students about the interpretations. One cookie equals one coal deposit.
 - a. After 15 seconds how many coal deposits were consumed?
 - b. After 30 seconds how many?
 - c. After 45 seconds how many?
 - d. After 60 seconds, 75 seconds, 90 seconds, etc.?
5. Distribute the second cookie. This time children can only take a bite when you say, "Take a bite" (every 15 seconds). The system is the same — the student raises a hand when finished and you tally every 15 seconds.
6. Construct Graph No. 2 (same format)

This graph usually indicates that coal resources last longer.
7. Analyze the data. How long did it take for all resources to be eliminated?

CONTROLLING RATE OF CONSUMPTION OF COAL

8. Compare Graph No. 1 (unlimited consumption) to Graph No. 2 (limited consumption). How do the results differ? What is the same? When interpreting data, have 10 seconds equal 10 or 100 years. For example: If Graph No. 2 lasted 30 seconds longer when consumption was controlled, $30 \text{ seconds} \times 10 = 300 \text{ years}$. Then go into implications for actual coal deposits and rates of consumption.
9. Using divergent questioning techniques
 - a. Tell why you think coal was consumed at different rates.
 - b. How did we control the rate of consumption on our second experience?
 - c. Does this have any implications for us as we use coal, electricity and natural gas?
 - d. Can we help control how rapidly we use resources?
 - e. Give your own ideas as to how we can do this.
10. The lesson can be enhanced by expanding it as a result of student and teacher brainstorming.

THE SHORT TRIP

Source: Citizen Action Guide to Energy Conservation
Citizen's Advisory Committee on
Environmental Quality
1700 Pennsylvania Avenue, N.W.,
Washington, D.C. 20006

Class: Social Studies or
Mathematics
Grades: 4-6
Time: 30 minutes

Concept: If Americans cut down on the use of their automobiles, less gasoline will be needed.

Objective: To determine how families could combine short trips figuring the number of miles saved weekly and yearly.

Materials: None

Background: Americans like to use their automobiles. In fact, 54 per cent of all car trips in this country are less than five miles. Doesn't that seem unnecessary when frequently we could use public transportation, a bicycle, or walk? Interestingly enough — traveling on family business — going to the doctor or dentist or going shopping — accounts for 31.4 per cent of all passenger car trips and averages 5.5 miles one way.

What would happen if each family took one less trip a week, for example, seven instead of eight. By planning ahead to combine errands and appointments, an average family can save \$74 a year. This may not be impressive enough on a family scale to some, but if every family did this we would save nationwide:

- 38 billion miles of driving;
- 2.9 billion gallons of gasoline; and,
- more than \$1.5 billion.

Procedure:

1. Review with the class the background material above.
2. Ask each student to make a list of typical short trip "destinations" his family makes in an average week.
3. Ask students to give reasons for the excessive number of short trips taken per week by his family.
4. Each student should then plan a daily "trip schedule" which conveniently combines many of the short trips into a few consolidated excursions.
5. Assuming an average of 11 miles (round trip) per short trip, how many miles could be saved in one week? In one year?

DRAGGING SUITCASES

Source: Computations About the Sources
And Conservation Of Energy,
Florida State Energy Office,
Tallahassee, Florida

Class: Science or
Mathematics
Grades: 4-6
Time: 20 minutes

Concept: To conserve energy, it is evident that one must accomplish a task with the minimum amount of work. In the process of doing work, the less resistance, drag or friction one must work against, the less energy is expended.

Objective: To study the effects of friction/resistance to movement.

Materials: Chalkboard and chalk

Procedure:

1. Copy the following problem on the chalkboard.
Suppose a car averages 25 miles per gallon of gasoline on long trips when the suitcases are on a luggage rack on top of the car. By putting the luggage in the car (reducing air friction) you get 8% better mileage.
2. Using a map of your state, figure the number of miles from a city on the west side to a city on the east side.
 - a. Compute the number of miles per gallon the car would gain with the luggage in the car.
 - b. Compute the number of gallons, to the nearest tenth, used in traveling with the luggage:
1) on top of the car, 2) in the car.
 - c. Assuming a cost of 95¢ per gallon for gasoline determine the money saved on the trip by packing the luggage in the car instead of on the roof.

TANGLED IN THE ENERGY WEB

Source: Energy Information Associates Inc.
Littleton, Colorado

Class: Social Studies or Science
Grades: 4-6
Time: 1 class period

Concept: Many aspects of our lifestyle have become dependent upon nonrenewable fossil fuel supplies.

Objective: To teach the students the effects of the depletion of fossil fuel reserves on our lifestyles.

Materials: Copy of President Carter's April 20, 1977 energy address
Various lengths of yarn or string
Paper for name tags
Felt-tip markers or crayons

Procedure:

1. On April 20, 1977, President Carter, in his energy address made several references to "the good life". Ask students what this expression means to them.
2. Have students brainstorm those aspects — products, services, necessities — important to "the good life" which affect the American lifestyle.
3. With the students' help consolidate elements until the total equals the number of students in your class. Assign each student to play the "role" of one good life element. Make a "name tag" for each student. You may wish to make one for yourself which reads "Government".
4. Have students stand in a circle. Using lengths of yarn connect elements of the good life to others upon which they may depend. A web of interdependencies will form. Nearly all of the elements are subject to governmental control, and, if you are standing in the middle of the circle, you will become hopelessly entangled.
5. Stimulate a production crisis of the fossils fuels by asking those students to carefully remove their strings from other elements which depend on them. The result is a near collapse of the web.
6. Many aspects of "the good life" face potential collapse when fossil fuels are removed. Discuss how society is weakened when almost totally dependent on one element — fossil fuels. Discuss how society can be strengthened by a diversity of energy sources. What are some of the possibilities?

RENEWING FOSSIL FUELS

Source: Our World of Energy Activities Booklet
Energy Education Advisory Council,
Philadelphia Electric Company
Philadelphia, Pennsylvania

Class: Science
Grades: 4-6
Time: 2 class periods

Concept: Energy sources are both renewable and nonrenewable.

Objective: To teach students to distinguish between renewable and nonrenewable energy sources, including the meaning of recycling energy.

Materials: Pieces of natural fibers used in clothing
Synthetic materials used in clothing

Procedure:

1. Introduce the word renewable.
2. Ask students which parts of their bodies are renewable. (They might suggest hair, fingernails, skin, blood cells.)
3. Ask students for suggestions of parts of their bodies which are not renewable. (Responses might include a finger, permanent teeth, tonsils, and appendix.)
4. Remembering what is renewable on the body, have students name some renewable materials from which clothing is made. Show students some of the renewable fibers or fabrics (cotton and wool).
5. Have students examine the clothing they are wearing and see if they can discover some examples of nonrenewable fabrics. Some possibilities include nylon, orlon, rayon, plastics (as in buttons and zippers), and polyesters.
6. Have students bring materials or objects for classification as renewable or nonrenewable.
7. Having established what is meant by renewable and nonrenewable, point out that these terms also apply to energy sources.
8. Have the class list energy sources on the board and decide which belong in each of the two categories, renewable or nonrenewable.

HOW QUICKLY DOES IT COOL?

Source: Energy In The Classroom
Virginia Energy Office
Richmond, Virginia

Class: Science
Grades: 5-9
Time: 30 minutes

Concept: Heat lost by conduction is directly proportional to a temperature difference (the driving force) and inversely proportional to the thermal resistance of the insulating medium.

Object: To teach students how thermal insulation reduces heat loss.

Materials: Small box
Thermometer
Insulating materials
Chalkboard

- Procedure:**
1. Place a thermometer in a glass of hot water or coffee. Read the temperature every five minutes.
 2. Have students help make a graph of temperature vs. time on the chalkboard. Now, put a fresh glass of hot water or coffee inside a box and pack cotton balls, fiberglass insulation, or crumpled paper around it.
 3. Make a graph of temperature against time as before and compare with the previous case; the effects of the insulation will be obvious.
 4. If time permits, have students "invent" their own insulation material. Repeat step 3.

DON'T BE A BIG DRIP — SAVE LITTLE ONES

Source: Northern Colorado Board of
Cooperative Services
Longmont, Colorado

Class: Mathematics or Science
Grades: 6-8
Time: 2 class periods

Concept: A relationship exists between awareness of energy sources and the conservation of energy.

Objective: To increase awareness of energy wasted by computing liquid volume using multiplication and division skills.

Materials: 8 ounce glass or plastic measuring cup
Pencil and paper
Leaky faucet
Clock

- Procedure:**
1. Place measuring cup under a dripping hot water faucet and collect 15 minutes of drips.
 2. Compute how much energy was wasted.
 - a. Multiply number of ounces of water by 4
Example: $4 \text{ oz.} \times 4 = 16 \text{ oz. per hour}$
 - b. Multiply answer in (a) by 24
Example: $16 \text{ oz.} \times 24 = 384 \text{ oz. per day}$
 - c. Multiply answer in (b) by 365
Example: $384 \text{ oz. per day} \times 365 = 140,160 \text{ oz. per year}$
 - d. Divide answer (c) by 128
Example: $140,160 \text{ oz. per year} \div 128 = 1,095 \text{ gallons per year}$
 - e. For oil fired hot water heater — divide answer (d) by 110, which gives the approximate number of gallons of oil wasted.
Example: $1,095 \div 110 = 9.95 \text{ gallons of oil per year}$
 - f. For gas fired hot water heater — divide answer (d) by 0.84, which gives the approximate number of cubic feet of gas wasted.
Example: $1,095 \div 0.84 = 1,304 \text{ cubic feet of gas per year.}$
 - g. For electric hot water heater, multiply answer (d) by 0.25, which gives the approximate number of kilowatt hours of electricity wasted.
Example: $1,095 \times 0.25 = 274 \text{ kilowatt hours}$

THE TROUBLE WITH EXPONENTIAL GROWTH

Source: Energy and Earth
The Jefferson County Public Schools,
Jefferson County, Colorado

Class: Social Studies or
Mathematics
Grades: 7-12
Time: 1 class period

Concept: Exponential growth is geometric growth (on a pattern, for example, of 1, 2, 4, 8, 16), rather than arithmetic growth (on a pattern of 1, 2, 3, 4, 5). Exponential growth is growth at a fixed percentage rate over a period of time (savings account at compound interest is a standard illustration).

Objective: To explore how consumption of energy coupled with exponential growth leads to depletion of energy resources.

Materials: Checkerboard for each student
Five pounds of rice

Background: To understand the implications of exponential growth in population, in resource consumption or in pollution levels, calculate the doubling time of a growing quantity. A handy rule of thumb is to divide the per cent rate of such growth into the number 70 to arrive at the doubling time. For example, the population of the world, now roughly four billion persons, is growing at about 1.6 per cent per year. The doubling time is 70 divided by 1.6, or 44 years. So long as that rate of growth holds constant, we can calculate the future population as follows:

- | | |
|-----------------|---------------------------|
| | 4 billion people in 1975 |
| • plus 44 years | 8 billion people in 2019 |
| • plus 44 years | 16 billion people in 2063 |

To say this another way, a child born in 1975 who lives 88 years will experience first hand what it is like in a world of 16 billion persons or will witness first hand what it was that intervened to forestall the 16 billion.

The U.S. growth rate for electric consumption is illustrative. For much of the 20th century, it was 7 percent a year, doubling each decade ($70 \div 7 = 10$). This meant that, besides replacing obsolete facilities, utilities had to double their usable generating capacity each ten years. Plotting this progression on a simple graph would give a visual idea of the impact of such growth, if it were to continue for two more doubling times from 1970. In fact, many industry experts were predicting just such a growth rate, but since the embargo, consumption has moderated; the industry now projects slower rates of growth.

This moderation in growth rate also may be illustrative of a general slowdown both of U.S. population growth and of growth in energy use. It is wise to keep in mind, however, that even lesser growth rates are exponential — that is, they do lead to doublings, even though the doubling time is lengthened.

The following exercise illustrates the arithmetic of doubling exponential growth, and suggests there are limits to exponential growth of any quantity.

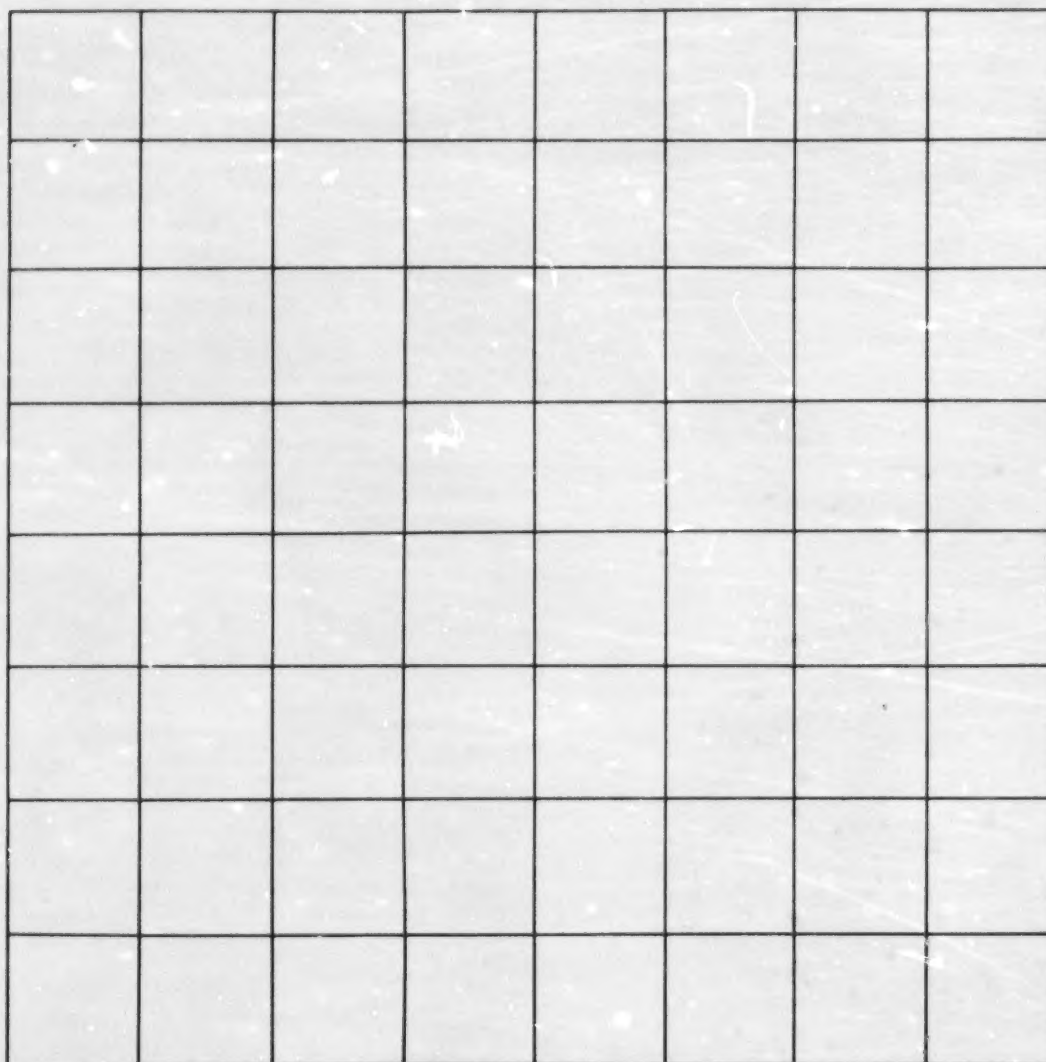
THE TROUBLE WITH EXPONENTIAL GROWTH

- Procedure:**
1. Give each student a checkerboard, some rice and directions to place one grain of rice in the lower left hand square, two grains in the next square, four in the next, eight in the next, 16 in the next and continue this pattern. Have students estimate the amount of rice they will need. When students realize they have run out of room and are faced with an impossible task, discuss these questions in class.
 - a. Were you able to fill all the squares? If not, why not?
 - b. How is the doubling of rice grains in the squares like our current consumption of energy?
 - c. What will happen if we continue to consume energy at our present rate of consumption?
 2. Discuss the game of "Rice Checkers". There are 64 squares on the board. If the number of grains of rice is doubled 63 times, that will be 2 to the 63rd power grains of rice on the 64th square. They would have to put more rice in the last square than there is rice in the whole world. No one was able to complete the game because he ran out of room. The current consumption of energy is increasing at a rapid rate too.
 3. Show students how to calculate doubling time t_2 , using the following expression:

$$t_2 = \frac{70}{\text{annual \% growth rate}}$$

4. Calculate t_2 for each of the following examples:
 - a. Inflation (and electricity consumption) at 7% per year.
 - b. Population at 1.64% per year.
 - c. Energy consumption at 3% per year.

RICE CHECKERBOARD



HOW'S YOUR ENERGY?

Source: Jerry Dunn
Ames High School
Ames, Iowa

Class: Science or English
Grades: 10-12
Time: 3 weeks

Concept: High school students become aware of current reference materials on energy and organize their information and thoughts regarding energy sources available to man.

Objective: To help students focus on the "What, Where, How and Why" of four selected energy sources as they explore reference materials and become aware of available energy sources.

Materials: Mini-packet on "How's Your Energy?"
Students will locate their own reference materials.

Procedures: Have students complete mini-packet.

Most of us use the word energy every day of our lives: "I have just lost all of my ENERGY. There is supposed to be an ENERGY crisis. The sun's ENERGY is warming the air. Our house is designed to save ENERGY." We all use the word but do we all know what we are really talking about? What is ENERGY, and where do we get the stuff?

Using reference books such as textbooks, encyclopedias, dictionaries, magazines, etc., answer the following questions to the best of your ability. The total packet is worth 100 points and will be evaluated as follows:

- 20 points — introduction
- 60 points — research — 15 points for each source
- 20 points — experiment, demonstration or drawing used to show how one of the energy sources is available to mankind.

Possible Points

INTRODUCTION

- 1-4 We use several forms of energy each and every day of our lives. Write the definition of energy as stated in four different reference books. List the book, its copyright date, and the definition.
- 5-10 According to the thinkers of our day, all matter in the universe contains energy. Albert Einstein suggested that the relationship between matter and energy is a very close one. In fact, he suggested that one day we will understand how to convert matter into energy and energy into matter. This sounds good to most people, but just what is the matter? List at least six different forms of energy which might be available to you on a daily basis.
- 11-13 Write the definition of matter as stated in three different reference books. List the book and its copyright date with the definition.
- 14-18 Using your definition of matter, list at least five forms of matter that you came in contact with on your way to school this morning.
- 19-20 If all the matter listed contains energy, and the energy is not doing some work (causing something to move) then it must be stored energy. We call this _____ (19) _____ energy. The matter which came in contact with that which was causing something to move or do work can be said to possess _____ (20) _____ energy.

HOW'S YOUR ENERGY?

RESEARCH

It becomes clear that our lives are dependent upon many forms of energy to help us do work. We drive cars, heat our homes, light our schools, grow our food, and in general use it for survival and convenience. In almost all cases this energy is not readily available in the form we can use. For example, we cannot pick up a sunbeam to run a fireplace. Energy to heat your room is locked up in wood, coal or petroleum. As intelligent human beings we have been able to take this potential energy and convert it into kinetic energy to serve our needs. We are the only animals on earth which have been able to do so.

One form of energy used by man is in the form of heat. Heat keeps us warm, moves our motors and machines, make our meals, and provides us with artificial light (electricity).

In the remaining portion of this mini-course we will explore some potential sources of heat energy which are available to the world's human population.

60 Select four potential sources of heat energy used by people, i.e., coal, peat, natural gas, oil, etc. Research each heat source. Be sure to list reference, author and date the article was presented.

1. What source of potential energy are you investigating?
2. What is the energy used for?
3. What percentage of the United States energy is supplied by this source?
4. Where can this energy be found in greatest abundance?
5. Where does the United States obtain this source of energy?
6. Where are the waste products used, stored or gotten rid of?
7. How do we collect this energy?
8. How efficient is this energy as a source of heat?
9. How is this energy stored for later use?
10. How much energy is remaining for our future use?
11. Why is this a good source of energy?
12. Why is this a poor source of energy?
13. Why isn't this source of energy used more extensively?
14. Why are we concerned about the future use of this energy source?
15. In your opinion will we be using more, less, the same amount of this form of energy in 1990?

20

DEMONSTRATION

Pick one of the four sources of potential energy researched and demonstrate either with an experiment or with a drawing how that energy is made available for man's use. Demonstrations in which quantitative data are presented will be valued more than simple illustrations of principles.



GLOSSARY

Active solar energy	Energy derived from the sun through mechanical means, i.e., solar collectors or panels and solar cells.
Biomass	Every kind of organic substance that can be turned into fuel.
Building envelope	The physical elements which make up the exterior of a building.
Chimney effect	The tendency of air or gas in a duct or other vertical passage to rise when heated due to its lower density compared with that of the surrounding air. In buildings, the tendency toward displacement (caused by temperature differences) of internal heated air by unheated outside air due to the difference in density of inside and outside air.
Coal gasification	Process of converting coal to gases.
Coal liquefaction	Process of converting coal to liquid fuel.
Conventional fuel	Oil and natural gas.
Energy	The capacity for doing work, taking a number of forms which may be transformed from one to another, such as thermal (heat), mechanical (work), electrical and chemical.
Energy audit	Examination of a building's architectural and mechanical drawings, energy usage patterns, and fuel history in order to identify energy conserving opportunities.
Fumarole	A hole in a volcanic region from which hot gases and vapors issue.
Geothermal energy	Energy that is derived from the earth's heat.
Hydropower	Electricity generated by water as it falls and turns turbines.
"In Situ" process	A process by which oil is "cooked" out of the shale underground.
Methane	The major ingredient in natural gas.
Passive solar energy	Energy derived through architectural designs, building placement on the site and building materials that allow the structure to take advantage of the sun's energy.
Photovoltaics	Solar cells that are electrical semiconductors made primarily from silicon that convert sunlight into electricity.
Proved reserves	Oil and natural gas which have already been found recoverable in future years under economic and operating conditions as they now exist.
Pyrolysis	Process of applying heat to pulverized coal which produces liquids and gases.
Renewable energy sources	Energy that is derived from natural forces such as the earth's heat, the ocean's tides, rivers, winds and the sun.
Reserves	Recoverable crude oil and natural gas still untapped in the earth.
Shale	A marlstone, containing kerogen which is partially formed oil.
Solvent refining	Process of converting coal into a liquid heavier than crude oil.
Synthetic fuel (synfuel)	Oil and gas derived from coal, and oil extracted from shale and tar sands.
Tar sands	Sands saturated with heavy oil and tar.



RESOURCE MATERIALS

The following brief list of resource materials is provided for teachers and students as additional information on the energy issues and energy technologies. Also, additional general information can be obtained by writing the U.S. Department of Energy, your State Energy Office or local utility company.

Emerging Energy Technologies: Energy Research — Answers to Your Questions

Coal — Answers to Your Questions

Nuclear Power — Answers to Your Questions

Edison Electric Institute
Publications Office
1111 19th Street
Washington, D.C. 20036

Energy in America's Future: The Choice Before Us

Schurr, Sam H., et al.

A study conducted by Resources for the Future National Energy Strategies Project
The Johns Hopkins University Press, 1979

Energy Future

Report of the Energy Project at the Harvard Business School
Robert Stobaugh and Daniel Yergin, editors
Random House

Fortune Magazine

A Progress Report on Alternative Energy Sources
Volume 100, No. 6
September 24, 1979

Our Energy Problems and Solutions

Energy Conservation Research
9 Birch Road
Malvern, Pennsylvania 19355

Recommendations and Summary Findings

The President's Commission on Coal
John D. Rockefeller IV, Chairman
U.S. Government Printing Office
Washington, D.C., 3 March 1980

Study of Nuclear and Alternative Energy Systems

U.S. Energy Supply Prospects to 2010
National Academy of Sciences
Washington, D.C., 1979

The World Oil Market in the 1980's: Implications for the U.S.

U.S. Congressional Budget Office
Washington, D.C., May 1980

***Tips for Energy Savers* (DOE/OPA0037)**

U.S. Department of Energy
Editorial Services, GA-343
Office of Public Affairs
Washington, D.C. 20584

Note: Other publications on energy and energy conservation are available through DOE:

Two Energy Futures: A National Choice for the 80's

American Petroleum Institute
2101 L Street, N.W.
Washington, D.C. 20037

The following booklets can be obtained in quantity for your students by writing:

Channing L. Bete Co., Inc.
45 Federal Street
Greenfield, Massachusetts 01301

Booklets

Energy Crisis: Is the Earth Running Out of Energy?
How You Can Save Energy
Conserve Energy at Home
About Solar Energy
What Everyone Should Know About Oil Shale
What Everyone Should Know About Coal Gasification
The ABC's of Oil
Offshore Energy
What Everyone Should Know About Electricity
The ABC's of Electricity
The Story Behind the Switch
Electric Power and the Atom